

Cardiovascular and relative exertion perceived response during proprioceptive neuromuscular facilitation exercise associated to pulley.

Respostas cardiovasculares e da percepção subjetiva de esforço durante exercício com a técnica de facilitação neuromuscular proprioceptiva associada a polia.

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Abstract

Introduction: The use of pulley together with proprioceptive neuromuscular facilitation (PNF) are described how an excellent approach for several exercises, but prescribe with safety is very difficult and it's a failure in the rehabilitation area, yet. **Objective:** To measure the hemodynamic changes and the relative exertion perceived through OMNI - RES scale after use PNF exercise together pulley. **Method:** 10 healthy sedentary women performed the exercises with right upper body together with PNF and pulley load. It was performed 3 sets with 10 repetitions and measurement blood pressure, heart rate and perceived exertion among the three series. ANOVA *post hoc* Bonferroni, accepting $p < 0.05$. **Results:** One subject dropped out due to lack of exercise program adherence. In the hemodynamic's data was observed significance differences in HR (1st, 2nd and 3rd in relationship at rest, $p < 0.05$), PE (1st, 2nd and 3rd in relationship at rest, $p < 0.05$). In the perceived exertion was difference among 3rd set in relationship for 1st set ($p > 0.05$). **Conclusion:** The use of exercises with the PNF patterns associated with pulleys do not produce great cardiovascular influences, be safe in healthy individuals.

Keywords: PNF; Resistive exercise; Haemodynamic; Health.

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Resumo

Introdução: O uso de polia associado com a facilitação neuromuscular proprioceptiva (FNP) é descrito como uma excelente abordagem para vários exercícios resistidos, mas prescrever com segurança ainda é falho na área da reabilitação.

Objetivo: Avaliar as alterações agudas pressóricas e da percepção subjetiva de esforço após exercício com membros superiores através da técnica de FNP associado à polia. **Método:** 10 mulheres, saudáveis e sedentárias realizaram os exercícios de membro superior com a técnica de FNP associado a polia. Foi realizado uma sessão com três séries de 10 repetições. Foi avaliado a pressão arterial sistólica (PAS) e diastólica (PAD), frequência cardíaca (FC), duplo-produto (DP) e percepção subjetiva de esforço (PSE) durante as três séries. Para a análise estatística foi utilizado ANOVA uma *viapost hoc* Bonferroni, sendo aceito $p < 0,05$. **Resultados:** Em relação aos valores hemodinâmicos foram observadas diferenças na FC (1ª, 2ª e 3ª em relação ao repouso, $p < 0,05$) e no DP (1ª, 2ª e 3ª em relação ao repouso, $p < 0,05$). Na percepção subjetiva de esforço houve diferença entre 3ª série em relação a 1ª série ($p > 0,05$). **Conclusão:** O uso de exercícios com os padrões do FNP associados a polias não produzem grande influencias cardiovasculares, sendo seguros em indivíduos saudáveis.

Palavras-chave: FNP; Exercícios resistidos; Hemodinâmicos; Saúde.

INTRODUCTION

Clinical studies and scientific societies recommend the use of resistance exercise (RE) as an adjunct to treatment of cardiovascular disease.⁽¹⁻³⁾ The beneficial effects are related to the increase in muscle strength, functional capacity, increased well - be physically and mentally and the positive impact on cardiovascular risk factors.⁽³⁾ Rehabilitation programs recommend that the resistive exercises be performed with large amplitude movements,⁽²⁾ and for this, the physiotherapists use the concept of proprioceptive neuromuscular facilitation (PNF).⁽⁴⁾

The PNF is a concept in principle use diagonal and spiral exercises to mimic human functional movements⁽⁵⁾ and has correlation with the movements performed during activities of daily living.⁽⁴⁾ In classic form, the application of the technique is performed with manual and the resistance contact is applied by the therapist himself.⁽⁵⁾ However, weights, such as pulleys, can be associated with specific patterns of PNF, which facilitates the increase of muscle strength and joint range of motion.⁽⁶⁾ However, no study describes how to prescribe this exercise modality using pulleys.

Currently, there are several ways to prescribe the RE, the most common the test of a maximum repetition (1RM) and the rating of perceived exertion (PE).⁽²⁾ These tests are simple tools and practices which the practitioner can perform without too much difficulty. Moreover, it is now known that resisted incremental loads, from 30% 1RM, have a high correlation with cardiac sympathetic activity, blood pressure, muscle metabolic and PE,⁽⁷⁾ and the knowledge of these variables an excellent tool to facilitate prescription and carrying out the exercises safely. Finally, given the need for better understanding of pressure behavior and perception of effort during the course of PNF technique associated with pulley, the objective of the study was to identify the behavior of these variables during a workout in healthy young subjects.

METHODS

Sample

Were selected for the study, 10 female volunteers, young, healthy and right-handed. The volunteers were invited to participate in the study through public calls at the Universidade Federal do Amazonas (UFAM). Inclusion criteria were: Normotensive,⁽⁸⁾ aged 18 to 25 years, being right-handed according to the Edinburgh handedness questionnaire⁽⁹⁾ and sedentary according to the physical activity questionnaire (IPAQ).⁽¹⁰⁾ Exclusion criteria were: being low weight or being obese ($BMI \leq 20$ kg/m² or ≥ 30 kg/m²), smoke, have hormonal disorders, neuromuscular disease, are pregnant, making use of antihypertensive medication, bronchodilators or any drug affecting the cardiovascular responses. All subjects read and signed the free and informed consent. The study was approved by the institutional ethics committee and was performed in accordance with the ethical standards with the number 069/11.

Tools

For load selection we used the one repetition maximum test (1 - RM). The 1-RM test was performed with pulley with voluntary sitting alongside the front of the pulley apparatus in a chair with a back. The movements used in the study were the deflection - abduction - external rotation with the elbow extended and extension - adduction - internal rotation with the elbow extended (Figure 1A and B). It also had minimum charge of 2 kg and maximum load of 10 kg, and the cable pulley was positioned in the right wrist with cuff, leaving her free hand, thus allowing the use of standard PNF correctly. (Figure 1A). If a participant did not get as load 100% of 1-RM 10 kg in the pulley, the volunteer was excluded because the study using values up to this load.

Changes in systolic blood pressure (SBP) and diastolic blood pressure (DBP) were evaluated by digital pressure

device (HEM 742, Omron, Vernon Hills, Illinois, USA)⁽¹¹⁾ heart rate (HR) was assessed by the portable heart monitor (FT1, Polar, Kempele, Finland). The measurements of SBP and DBP were performed at rest and at the end of the exercise series. In the exercises, the values were measured in the left arm, and in the seventh repeat the device was turned on for the parameters immediately at the end of the series. To assess the HR, was used the peak value of the frequency during the series. To determine the values of the double product (DP), was made the calculation by SBP x HR.

For the PE measurement was used to scale OMNI-RES active member and the whole body⁽¹²⁾ According to the OMNI scale - RES, stress levels are classified as extremely easy (0-1), easy (2-3), a little easier (4-5), a little hard (6-7), difficult (8-9), extremely difficult (10).

Procedures

For the experimental procedure followed the movement of the basic procedures used in PNF concept. The standard used was flexion - abduction - external rotation with the elbow extended, and extension - adduction - internal rotation with the elbow extended, and the specific technique was reversal of antagonists⁽⁵⁾ (Adler, Beckers, Buck, 2007) (Figure 1A and B). The time of the exercises took place in the late afternoon and early evening. The volunteers



Figure 1. PNF pattern associated with pulley A. flexion movement - abduction - external rotation with the elbow extended and B. extension movement - adduction - internal rotation with elbow extended.

performed the exercises on another day of the choice of 100% 1 - RM, with a minimum interval of 48 hours between them. The protocol consisted of three sets of ten repetitions with rest time between sets of 60 seconds during the year was always encouraged to avoid breathing to avoid the Valsalva maneuver during executions.

Statistical analysis

Data were tabulated as mean \pm sd. To determine the normal distribution, we used the Shapiro -Wilk test. For paired data was used the Student t test and the non-paired data was used ANOVA post hoc Bonferroni. The significance level was $p < 0.05$. The statistical program used was Graph Pad Prism.5.0. (GraphPadSoftware Inc., CA, USA)

RESULTS

Ten volunteers were selected, but a voluntary withdrew from the study after evaluation of 1RM, finishing with 09 volunteers at the end of the study. Tables 1 and 2 are the anthropometric values and the absolute values of loads used by each volunteer, respectively.

Table 1. Anthropometric values, baseline hemodynamic and load used. Mean \pm sd.

N = 09	
Age (Years)	21.0 \pm 1.2
Weight (Kg)	58.3 \pm 10.6
Height (meters)	1.5 \pm 0.05
BMI (Kg/m ²)	23.2 \pm 3.0
SBP (mmHg)	106 \pm 9.7
DBP (mmHg)	67 \pm 7.6
MBP (mmHg)	80 \pm 7.2
HR (bpm)	80 \pm 7.7
100% 1 - RM (Kg)	7.1 \pm 1.2
Average Load (Kg)	6.0 \pm 1.4

BMI = Body Mass Index; Systolic blood pressure; DBP: Diastolic Blood Pressure; MBP: mean blood pressure. HR: Heart rate, 1 - RM = one maximum repetition.

Table 2. Absolut values of 1RM % and load.

Subject	100% 1 - RM	Load	% 1 - RM
01	10 kg	8 Kg	80%
02	8 kg	6 kg	75%
03	6 kg	4 kg	66%
04	8 kg	6 kg	75%
05	8 kg	6 kg	75%
06	6 kg	4 kg	66%
07	8 kg	6 kg	75%
08	10 kg	8 kg	80%
09	8 kg	6 kg	75%

Table 3. Values pressure, heart rate and perceived exertion between series. Mean \pm sd.

	Rest	1 st set	2 nd Set	3 rd set
SBP (mmHg)	104 \pm 3.2	115 \pm 6.1	120 \pm 3.8	117 \pm 4.5
DBP (mmHg)	68 \pm 2.7	80 \pm 5.2	79 \pm 4.6	81 \pm 4.3
HR (bpm)	81 \pm 3.1	98 \pm 4.4*	99 \pm 4.2*	101 \pm 3.0*
DP (bpm.mmHg)	8399 \pm 499	10994 \pm 797*	11946 \pm 578*	11941 \pm 660*
OMNI - RES _{limbs}	0	3.6 \pm 0.6	4.7 \pm 0.8	6.3 \pm 0.7**
OMNI - RES _{body}	0	2.5 \pm 0.6	2.4 \pm 0.6	3.4 \pm 0.6

SBP: systolic blood pressure; DBP: Diastolic blood pressure; HR: heart rate; DP: Double product; OMNI - RES_{limbs} = Perceived exertion in the upper limbs; OMNI - RES_{body} = Perceived exertion in the body. *Rest x Sets ($p < 0.05$). **Difference between 1st and 3rd set ($p < 0.05$).

Table 3 shows the hemodynamic values and PE during the series. The data included SBP, DBP, HR, DP and OMNI - RES in the arm and whole body. The SBP and DBP had no significant difference between sets. It was noticed the increased in the HR and DP in all series. Regarding the HR, the values of first, second and third series were significant in relation to the rest. (Rest = 78 \pm 3.1, 1st set = 98 \pm 4.4, $p < 0.05$; rest = 78 \pm 3.1, 2nd set = 99 \pm 4.2, $p < 0.05$; rest = 78 \pm 3.1, 3rd set = 101 \pm 3.0, $p < 0.05$). The DP values followed the same responses of HR. (rest = 8.399 \pm 499; 1st set = 10,994 \pm 797, $p < 0.05$; rest = 8.399 \pm 499, 2nd set = 11,946 \pm 578, $p < 0.05$; rest = 8.399 \pm 499; 3rd set = 11,941 \pm 660. $p < 0.05$).

The value of PE between sets can be seen in Table 3. There was a significant increase in the first set value in relation to third set in PE in the active member (1st set = 3.6 \pm 0.6, 3rd set = 6.3 \pm 0.7, $p < 0.05$). In PE values on the body there was no difference between sets.

DISCUSSION

The main findings of the study were to demonstrate no difference in blood pressure responses and slight increase in HR, DP and PE in the exercise with PNF with upper limbs associated with pulley. To our knowledge there is no study which evaluates the pressure and PE behavior involving pulleys with the the technics of PNF.

Currently, resistance exercise is seen as an important component in physical activity program and rehabilitation. (3) In addition, the cardiovascular responses are important parameter for understanding and security in different application types of exercise performed. (13) Despite several studies showing the pressor effect during resistance exercise (14-16) there are few studies that attempt to identify the hemodynamic changes during resistance training associated with the PNF concept. (17-19)

Gültekin et al. (17) studied the pressor effect and the concentration of lactate after exercise with the arms associated with the PNF with manual resistance. The authors viewed increase in all hemodynamic parameters and lactate concentration after a single session of exercise

in healthy young women. In our study, only the HR and DP values were equivalent to working Gültekin et al. (17) Even viewing changes in blood pressure values between sets, they were not statistically significant.

The important point to be discussed on the difference between the studies is the use of manual resistance, which was different from ours, which used the fixed charge across the pulleys. The difficulty of quantifying the manual resistance applied the methodology can produce large effects isometric and Valsalva maneuver. (20) Studies have shown that isometric contraction increases the variables of cardiac autonomic control and pressure, because of the effect of the contraction in the vascular system active muscle (21) and the great stimulus of muscle ergoreceptors during this activity. (22)

The movement used in our study was based on the technique of reversal of antagonists and without pause to avoid the appearance of large isometric contractions during exercise. The technique used does not exempt the appearance of isometric contractions during activity, but can reduce this effect. Anyway, further studies are needed to evaluate muscle activity, such as the use of surface electromyography, to identify possible differences in muscle contraction exercises that use the fixed charge and the manual load resistance.

Regarding the Valsalva maneuver, McCartney (20) showed that resistance exercise with high loads favors the onset of the maneuver, and that the main effects are closely linked to increased intra - abdominal pressure and intrathoracic, resulting in an increase in blood pressure during exercise. In the current study, there was attention to avoid the Valsalva maneuver, keeping controlled breathing, which possibly prevented the appearance of the Valsalva maneuver and possibly did not affect the pressure increase

Yakut and Arian (18) showed that the use of the concept of PNF increases the blood pressure variables with increasing the number of repetitions for an exercise session, both in the exercises with the legs as in the exercises with upper limbs. The study evaluated the hemodynamic effect after a repeat, five replicates and ten repetitions, and in the

tenth repetition was the one with greatest increase in pressure variables. Again, the methodology applied in the study of Yakut and Arikan⁽¹⁸⁾ used the manual resistance to the exercises. The difficulty of regulation and evaluation of resistance used may overestimate the true effects of PNF on blood pressure variables.

Pereira⁽¹⁹⁾ evaluated the effect of different techniques of PNF in the exercises of the lower limbs of healthy elderly. In this study, the author did not view any increase in SBP and DBP after a workout. The author describes the hemodynamic response displayed in the study is due to use of a repetition in exercise session, however, the study of Gültekin et al.,⁽¹⁷⁾ have observed in only a repetition, significant increases in all hemodynamic variables evaluated. In addition, it is noteworthy that all studies that evaluated the hemodynamic effects during exercise with PNF used the simple sphygmomanometer. Currently, it is known that hemodynamic assessment of inactive members and immediately after stopping exercise may underestimate the pressure values by 13% and 30%, respectively.⁽²³⁾ Because of this, further studies are necessary to evaluate the hemodynamic effects through more accurate methodologies.

Traditional studies on resistance exercises describe major amount of muscles involved in resistance activity increases the blood pressure response. This response is due to the higher number of arteries compressed by exercise and by a larger number of peripheral receptors stimulated.^(20,24) Even involving large amounts of muscles, exercise used in our study did not cause significant blood pressure effects, requiring studies future comparing exercises with concepts of PNF and traditional exercise.

Another important response observed in our study was the increase in HR and DP during the series. Studies have shown that resistance exercise, regardless of type, produce direct influence on heart autonomic system and favors the increase in HR.⁽²⁵⁻²⁷⁾ The main explanation for this phenomenon is a reflex mechanism of the nervous system caused by the activity of muscle receptors which increase their activity due to mechanical stimulation, called mechanoreceptors or Type III receptor and through metabolic stimulation called metaboreflex or type IV receptor⁽²⁵⁻²⁷⁾ in this study, the possible activity of these receptors produced significant effects on HR and cardiac overload by an increase in DP.

Furthermore, it is possible that these receptors may influence the increased perception of effort exerted on the member by type IV receptor stimulation, which also has connections nociceptive.^(28,29) PE is determined as an estimate of the level of activation of central command.⁽³⁰⁾ Borg⁽³¹⁾ described that HR is directly related to PE and the local production of muscle lactate. This effect can speculate that the local metabolism during exercise is an important factor in the increase in HR and PE in our study,

however, the same has not been evaluated. In the study of Gültekin et al.,⁽¹⁷⁾ was proven that the exercise using the PNF technique increases the concentration of lactate after exercise, and possibly our study, the increase in HR and PE can be caused by this accumulation of lactate.

Study limitations

The main limitation of the study is the number of volunteers participating in the study, which may have underestimated the power of the study. Other limitation is that was not compared the hemodynamic effects with pulley and manual resistance, and was not used blind and controlled methodology.

CONCLUSION

It was seen no significant change in blood pressure with fixed charge associated with PNF used technique in the limbs, which can be safe in use and cardiovascular health disorders, but there is a need for better studies on the effect of changes in behavior autonomic in patients with cardiovascular disorders.

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